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ASSESSMENT AND EVALUATION OF ARTIFICIAL INTELLIGENCE CONTRIBUTION TOWARDS THE EARLY DETECTION AND DIAGNOSIS OF PERIODONTAL DISEASE IN INDIVIDUALS WITH MENTAL HEALTH DISORDERS

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Abstract
Machine learning (ML) is a crucial component of artificial intelligence (AI), and it's a common misconception that these terms, including deep learning, are interchangeable. The field of medical and dental diagnostics stands to gain significant advantages from this technological advancement. Therefore, a comprehensive understanding of AI and its fundamental components, such as ML, artificial neural networks (ANN), and deep learning (DP), is essential. The objective of this study was to assess the effectiveness of artificial intelligence in both preventing and diagnosing periodontal disease in individuals with mental disorders. This prospective research took place at Muhammad Dental College from February 2023 to July 2023 and involved a total of 527 patients of diverse genders who were diagnosed with mental disorders and presented with complaints related to periodontal disease. Detailed demographic information, including educational and socioeconomic status, was collected for all participants. The study evaluated the sensitivity and specificity of a novel AI system for identifying periodontal disease using intraoral images, adhering to the STARD-2015 statement guidelines for reporting accuracy. Statistical analysis was performed using SPSS 22.0. Among the participants, there were 305 males (57.9%) and 223 females (42.1%), with an average age of 47.5±16.52 years. Of the participants, 295 (55.97%) were smokers. The majority of

patients, 325 (61.7%), resided in urban areas, while 202 (38.3%) had rural residences. The most prevalent mental disorders were schizophrenia (50%), depression (29%), and anxiety (13%). Patients with more severe mental disorders, as indicated by the K6 scale index, exhibited a higher prevalence of periodontal disease. Intraoral images accurately detected periodontal disease (gingivitis) with an accuracy ranging between 88%, while AI models for detecting alveolar bone loss achieved an accuracy of 95%. The AI diagnosis had an accuracy rate of 0.90 for identifying healthy pixels and 0.92 for detecting disease pixels. This study underscored that individuals with psychiatric disorders tend to have poorer periodontal health compared to the general population. In addition to providing psychiatric care and therapy, it is advisable to incorporate a targeted preventive dental program. Artificial intelligence demonstrates the potential to identify specific areas with gingival inflammation or periodontal disease, as well as sites without these conditions, with a sensitivity and specificity comparable to those of a visual examination conducted by a human dentist.

Keywords: Periodontal disease, Artifical Intelligence, Accuracy, Specificity, Sensitivity, Mental Disorders

1. INTRODUCTION

Due to the complexity of its etiology, chronic periodontitis has been labeled a "multifactorial disease." Plaque is a biofilm that can be treated as the primary cause of chronic periodontitis because it houses specific periodontal bacteria. In [1] both the onset and the progression of periodontitis are affected by nonoral risk factors that are strongly linked to the disease's onset. Cigarette smoking, type 2 diabetes, family history, stress, depression, and attentiveness are all examples of kenned risk factors[2].

Major depression and subthreshold depressive symptoms are both prevalent psychiatric illnesses that can have serious consequences for a person's health[3]. Multiple studies have suggested a biologically plausible link between depression and periodontitis. In addition to potentially affecting one's periodontal health, research shows that mental health issues like depression and anxiety can alter one's immunological response, increasing one's susceptibility to developing a less-than-ideal state.[4]

Inflammatory disease of the tooth-supporting tissues known as periodontitis (PD) is distinguished by the breakdown of such tissues, which ultimately results in the loss of teeth. This condition is known as periodontitis. It is the most prevalent cause of tooth loss in adults, and it is the second most common oral illness in the globe; between 20 and 50 percent of the population is affected by it. Even while the microbial plaque biofilm is the primary source of the process, an exaggerated immune-inflammatory response from the host is responsible for much of the development of the process [1]. It has grown into a severe public health concern since it has such an important effect on the standard of life of individuals who are affected [2].

Caries and periodontal disease are the two main dental conditions that are important for patients with mental disorder. Dental caries is brought on by fermentation by bacteria of dietary carbohydrates, which results in tooth decay and ultimately loss (edentulism). Contrarily, gum disease is an aggressive illness affecting the tissues supporting and encircling teeth that is brought on by the buildup and dysbiosis caused by bacterial biofilm [4]. Periodontal pockets as well as gingival swelling, redness, and bleeding are symptoms of periodontitis. Edentulism and a bad quality of life are possible outcomes in the end. Additionally, there are connections to chronic conditions including heart disease, diabetes, and respiratory ailments, in part due to well-known risk factors like smoking and drinking. Due to the fact that periodontal and chronic inflammatory illnesses have mutually shared risk factors, there is a cycle that feeds into and amplifies inflammation [1-4].

The process for determining the amount of bone loss in impacted teeth and detecting alveolar bone loss has not changed substantially, despite recent advancements in treatment techniques. In along with periodontal probing, radiographs such panoramic, periapical, or bitewing radiographs constitute a few of the primary diagnostic techniques that can be used to recognise and predict PCT. The clinical evaluation and prognosis heavily depend on observational data [3].

The fundamental objective of applying AI in dentistry has been to improve the correction and speed of diagnosis, both of which are essential to ensuring that treatment is effective and that patients achieve the best possible outcomes [4]. When combined with clinical evaluation, artificial intelligence (AI) methods have the potential to be effective since they make the diagnostic process more accurate. The capability of artificial intelligence to recognise, categorise, and segment dental images has the potential to improve workflow. Image recognition and segmentation done with the most recent core model of artificial neural networks (CNNs) and deep learning in computer vision can assist in the diagnosis of periodontal disease. Radiographs are still an essential part of the diagnostic process. CNNs are able to recognise patterns and edges in PCT photographs. Deep CNN algorithms, which include of a large number of convolutional and hidden layers, can be trained to learn hierarchical feature representations using PCT pictures as the training data [5].

Understanding the differences between artificial intelligence, deep learning, machine learning, and data science is vital to gaining a comprehensive understanding of the discipline, despite the fact that many of these subfields have similarities. Data science, machine learning, deep learning, and artificial intelligence all have some similarities with each other as well as some differences. Learning by machine and deep learning are two subfields that fall under the umbrella of artificial intelligence. Data scientists utilise techniques from each of these fields in order to derive meaning and insight from the data they work with. The purpose of artificial intelligence, sometimes known as AI, is to endow machines with the same level of intelligence as humans in a variety of intellectual domains, including perception, speech recognition, decision making, and the processing of natural language. There are many different subfields that come together to form what is known as artificial intelligence. Some examples of these subfields are expert systems, robotics, and natural language processing. The subfield of artificial intelligence known as "deep learning" employs neural networks that are designed after the human brain in order to draw insights from enormous datasets. Deep learning allows for the training of algorithms that can automatically recognise and extract features from unstructured data such as pictures, audio, and text in order to form inferences and judgements from that data. Deep learning has a wide variety of applications, some of which include processing natural language, identifying images, and recognising audio. Machine learning is an area of artificial intelligence that focuses on the study and creation of methods that let computers learn from data without explicit guidance from their designers. It is possible to utilise supervised machine learning methods, in which the algorithm learns from data that has been labelled, unsupervised machine learning methods, or semi-supervised machine learning methods, in which the algorithm learns from both supervised data and data that has not been labelled. Examples of how machine learning has been put to use include predictive modelling, recommendation systems, and the identification of fraudulent activity. The purpose of data science is to get actionable insights from massive amounts of data through the application of domain-specific knowledge, statistical analysis, and computer techniques. The process of acquiring, cleaning, and preprocessing data are all included in the field of data science. Exploratory data analysis, statistical modelling, and machine learning are also components of this field. Just a handful of the many different industries that benefit from the application of data science include healthcare, finance, social media, and electronic commerce [6].

Although artificial intelligence has been put to use in a variety of settings throughout the course of history, only recently has it started to make its way into people's everyday lives. Despite the fact that artificial intelligence (AI) was initially utilised predominately in academic and government research organisations, its application in business and commerce has subsequently expanded significantly [7]. One of the first practical uses of artificial intelligence was seen in the 1980s and 1990s with the development of expert systems. These were computer programmes that were capable of making decisions in complicated fields such as medicine and finance in the same manner that a human expert might. Many of the products and services available to consumers in the 21st century make use of artificial intelligence (AI). Examples of artificial intelligence include virtual personal assistants such as Apple's Siri and Amazon's Alexa, as well as the recommendation algorithms used by companies like as Netflix and Amazon to adapt their services to the specific needs of individual customers. Other areas where AI is being put to use include driverless vehicles, the healthcare industry, and the financial sector.

Today, it is possible to distinguish between three distinct generations of AI [8]. In the history of artificial intelligence, there have been three generations: ANI, AGI, and ASI, which stands for artificial superintelligence. From where we are presently positioned, it is reasonable to assert that the first generation has totally saturated the market. First-generation artificial intelligence includes technologies such as Facebook's facial recognition and tagging system, virtual voice assistants available in smartphones such as Siri, Alexa, and Bixby, and the self-driving car technology created by Tesla and Google, amongst many more examples. Second-generation AI includes technologies such as IBM's Watson and Microsoft's Cortana. The next generation of artificial intelligence is designed to be able to think, plan, and carry out activities on its own. With the arrival of the third generation of artificial superintelligence, it is possible that people and the expertise they possess would become superfluous in some situations. In spite of the fact that 2001: A Space Odyssey is a work of fiction, Arthur C. Clarke's HAL 9000 gives a startling demonstration of the possibilities of third-generation artificial intelligence [9].

Recently, artificial intelligence has been utilised in the field of dentistry in a wide variety of applications, some of which include the detection of cavities, the prediction of treatment outcomes, and the design of biomimetic prosthetic teeth. The application of artificial intelligence to the detection of gum inflammation is an intriguing new discovery that has the potential to dramatically revolutionise the methods used to diagnose, treat, and even prevent gum disease [11].

Erythema, inflammation, and degradation of the crestal bone around teeth are all indications of periodontitis, which is caused by the body's inflammatory reaction to oral bacteria and other etiological agents owing to poor dental hygiene practises and/or environmental factors. Periodontitis can be prevented by practising good dental hygiene and maintaining a healthy oral environment[10-12].

Periodontal disease, often referred to as gum disease, is a common oral health condition that affects the gums and supporting structures of the teeth. It can range from mild gum inflammation (gingivitis) to more severe forms (periodontitis) that can lead to tooth loss if left untreated. While periodontal disease can affect anyone, there is evidence to suggest that individuals with mental health disorders may be at an increased risk for developing this condition. Several factors contribute to this association: Individuals with mental health disorders, especially severe conditions like schizophrenia or bipolar disorder, may have difficulty maintaining proper oral hygiene due to symptoms like apathy, cognitive impairments, or disorganized thinking. Poor oral hygiene is a significant risk factor for periodontal disease. Some medications used to manage mental health disorders, such as antipsychotic drugs, can lead to dry mouth (xerostomia) as a side effect [19]. Saliva plays a crucial role in oral health by helping to neutralize acids and wash away food particles, so reduced saliva production can increase the risk of gum disease and tooth decay. Mental health disorders can be associated with unhealthy lifestyle behaviors, such as smoking and a poor diet. These behaviors are also risk factors for periodontal disease. Chronic stress is common among individuals with mental health disorders and can weaken the immune system, making it harder for the body to fight off infections, including those in the mouth [11].

Some individuals with mental health disorders may face barriers to accessing regular dental care due to financial constraints, transportation issues, or dental anxiety [21]. This lack of access can lead to untreated oral health issues, including periodontal disease. It's essential to recognize the potential link between mental health disorders and periodontal disease and take steps to address it: Providing education on proper oral hygiene practices is crucial, especially for individuals with mental health disorders who may need extra support in maintaining their oral health [6,7].

Encouraging regular dental checkups can help identify and address oral health issues early, preventing them from worsening. Encouraging collaboration between mental health professionals and dental providers can help ensure that individuals with mental health disorders receive comprehensive care that addresses both their mental and oral health needs [30].

Mental health professionals should consider including oral health screening as part of their routine assessments to identify any potential issues and refer patients to dental care when necessary. Support individuals with mental health disorders in adopting healthier lifestyles and managing stress, as these factors can contribute to better overall health, including oral health [28].

It's important to approach this issue with sensitivity and understanding, as individuals with mental health disorders may face unique challenges in maintaining their oral health. Providing a supportive and integrated approach to care can help improve the oral health outcomes for these individuals on the other hand, mouth inflammation can increase the risk of systemic sickness and health difficulties by causing endotoxins to be released into the bloodstream. Untreated periodontal disease has been linked to an increased risk of cardiovascular disease, dementia, upper respiratory disease, cerebrovascular disease, and adverse birth outcomes. Additionally, untreated periodontitis has been related to an increase in diabetes-related morbidity and mortality, obesity-related morbidity and death, and pregnancy-related morbidity and mortality. Periodontitis can be prevented by getting regular dental cleanings and by avoiding sugary foods and beverages [13,14].

The treatment for periodontitis is called periodontal therapy, and it includes both the removal of periodontal calculus and the modification of lifestyle habits and risk factors [25,26].The systematic review and meta-analysis conducted by Luthra et al. shows that treating periodontitis is associated with a reduction in the concentration of C-reactive proteins, an indicator of systemic inflammation, for up to six months after treatment, even when antibiotics are not used as an initial adjunctive therapeutic modality. This effect is seen even when antibiotics are not used as an initial adjunctive therapeutic modality to treat periodontitis. Periodontitis treatment, as a consequence, brings to a reduction in inflammation not only in the affected region but also in other parts of the body [15,16].
The goal of this study is to evaluate the role that AI plays in periodontal disease diagnosis its relation with mental disorders and therapy, as well as its efficacy and any potential hazards that may arise as a result. The precision, effectiveness, and possible benefits of machine learning algorithms will be the primary focuses of the study. In specifically, the study will concentrate on the diagnosis and prognosis of periodontal disease.

2.METHODOLOGY

2.1: MATERIALS

This study was conducted after getting Ethical Approval letter from Muhammad Dental College, reference no. MDC/0238, from Feb 2023-July 2023. Methods in this study centered on creating and testing a machine learning model to predict the severity of periodontal disease after treatment had been administered, as well as validating the resulting dataset. Patients with mental disorders had age

>18 years were included. Patients with severe medical illness, did not provide written consent, and those did not have mental disorders were excluded.

2.2 METHOD

We added 527 patients, including their ages, smoking histories, periodontal disease severity before and after treatment, and treatment outcomes. Because of their potential impact on the development of periodontal disease, these factors were selected. The ages of the patients ranged from 18 to 75, and both the severity of the disease before and after treatment were rated on a scale from 0 (no severity) to 10 (extreme severity). '1' denoted 'yes' and '0' denoted 'no' for the categorization of smoking status and therapy. True positive rate, true negative rate, false positive rate, and false negative rate were used to evaluate the effectiveness of the AI system. The true-positive rate refers to the accuracy rate at which AI successfully detected a diseased status, whereas the true-negative rate refers to the success rate with which AI correctly recognized a healthy condition. A false-positive percentage & a false-negative rate were produced when AI wrongly classified healthy areas as infected and diseased locations as healthy. In the field of machine learning, the average intersection-over-union was a commonly used measure of performance for segmentation models. It was calculated by dividing the total of all four intersection-over-unions of sound, diseased, dubious, and background by 4. The accuracy scale ran from 0 to 1, with 1 representing perfect precision. The usual minimal acceptable forecast value was 0.50.

3. Model Validation:

We evaluated the model's success by calculating both the initial and modified R-squared values, which represent the proportion of the dependent variable's variation that can be attributed to the independent variables. We evaluated the model's adherence to the linearity, error independence, uniformity, and normality of its error distributions assumptions.

4. Statistical Analysis:

In order to summaries the demographic and clinical characteristics of the sample, descriptive statistics were used. This included the determination of means, standard deviations, and ranges for continuous variables, as well as counts, percentages, and frequencies for categorical ones. We also used inferential statistics to look for possible connections between the variables.

5. Limitations:

The machine learning model did rather well, but it only took into consideration a small subset of variables related to periodontal health, so it may have missed some important contributors to the development of the illness. With the use of this strategy, we were able to systematically explore the associations between demographic and clinical parameters and the severity of periodontal disease, and gain understanding of the predictive power of machine learning models for this condition.

6. RESULTS

There were 305 (57.9%) males and 223 (42.1%) females among all. Patients mean age was 47.5±16.52 years. 295 (55.97%) were smokers. Majority of the patients 325 (61.7%) had urban residency and 202 (38.3%) had rural residency as shown in table 1. Mood depression and schizophrenia was majority found in females as compared to males as shown in figure 2. In summary, while there may be some gender-related differences in the prevalence and presentation of depression and schizophrenia, both disorders can affect individuals of any gender. It is essential not to generalize or stigmatize these conditions based on gender, as they are complex and multifaceted mental health issues that require individualized assessment and treatment. If you or someone you know is struggling with depression or schizophrenia, it is important to seek professional help and support regardless of gender. It is true that depression is more commonly diagnosed in females than in males. This gender difference in prevalence has been noted in various studies and is often attributed to a combination of biological, social, and cultural factors. Females may be more likely to seek help for their symptoms, which can contribute to higher reported rates of depression.

Table-1: *Demographics of enrolled patients including info for smoking habit and nature of residency*

	Frequency (527)	Percentage
Gender		
Male	305	57.9
Female	223	42.1
Mean age (years)	47.5±16.52	
Smokers		
Yes	295	55.97
No	232	44.03
Residence		
Urban	325	61.7
Rural	202	38.3

Majority of the cases had schezophrenia, depression and anxiety as shown in figure 1. It's important to note that the prevalence of schizophrenia can vary by region, population, and over time. Several factors can contribute to fluctuations in reported cases, including changes in diagnostic criteria, increased awareness, and improved identification and reporting of cases. It's essential to rely on up-to-date and region-specific data to accurately assess the prevalence of schizophrenia. If you have concerns about schizophrenia or its prevalence in a particular area, it's best to consult with mental health professionals or refer to official health organizations and government statistics for the most accurate and current information [2,3].

Figure-1: *Types of mental disorders among all cases*

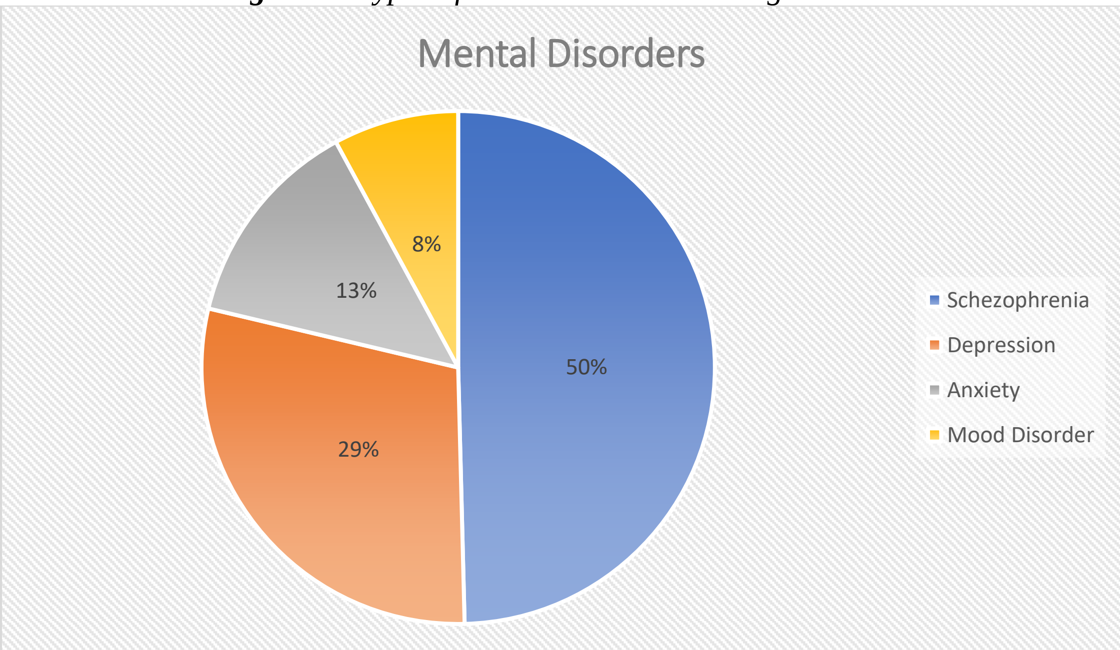
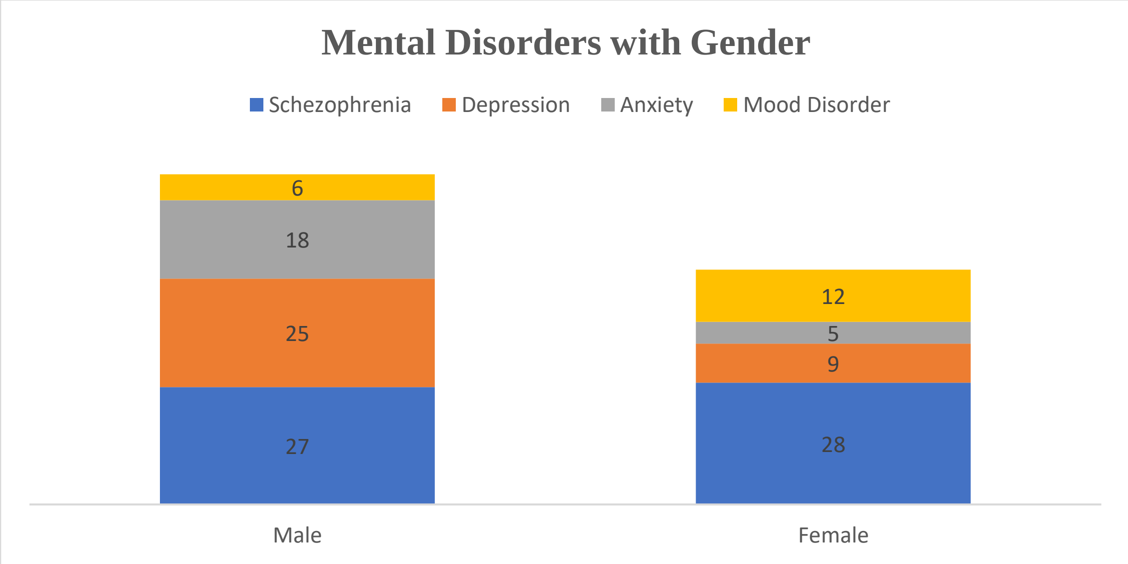


Figure-2: *Mental disorders with respect to gender depicting different percentage ratio gender wise*



Mental disorders can affect individuals of any gender, but there can be differences in the prevalence, presentation, and treatment of mental disorders based on gender. It's important to note that gender is a complex and multifaceted concept that goes beyond the binary understanding of male and female. It includes gender identity and the social roles and expectations associated with gender. When discussing mental disorders with respect to gender, it's essential to consider these factors [19]. Here are some key points to consider: Some mental disorders may have different prevalence rates among different gender groups. For example, depression and anxiety disorders are more commonly diagnosed in women than in men, while certain externalizing disorders like conduct disorder and antisocial personality disorder are more commonly diagnosed in men. The way mental disorders manifest and are expressed can vary based on gender and gender-related factors [17]. For example, men may be more likely to exhibit anger or irritability as symptoms of depression, while women may be more likely to report feelings of sadness or worthlessness. Societal and cultural expectations related to gender can influence the development and expression of mental disorders. Gender stereotypes and norms may affect how individuals perceive and seek help for their mental health issues. For instance, men may be less likely to seek help for mental health problems due to traditional masculine norms that discourage emotional vulnerability. Gender-based violence, including domestic violence and sexual assault, can have a significant impact on mental health. Survivors of such violence may experience conditions like post-traumatic stress disorder (PTSD) or depression. Gender dysphoria is a mental health condition experienced by some transgender individuals when their gender identity does not align with the sex assigned to them at birth. It's essential to provide appropriate and affirming mental health support for individuals experiencing gender dysphoria [21,22].

The approach to treating mental disorders may need to be tailored to the individual's gender identity and experiences. Cultural competence and sensitivity to gender-related issues are crucial for mental health professionals. The intersection of gender with other factors such as race, ethnicity, sexual orientation, and socioeconomic status can further complicate the experience and treatment of mental disorders. These intersections should be considered when providing mental health care. Continued research is needed to better understand how gender influences mental health and mental disorders. This research can help inform more effective prevention, diagnosis, and treatment strategies. It's important to approach the topic of mental disorders with sensitivity and respect for individuals' gender identities and experiences. Mental health professionals should strive to provide inclusive and affirming care that recognizes the diverse ways in which gender intersects with mental health.

Additionally, public awareness campaigns and policies should aim to reduce stigma and promote mental health equity for all gender identities.

Table-2: *Patients had severity of mental disorders had severe periodontal disease*

Variables	Severe MD (270)	Moderate MD (135)	Mild MD (122)
Periodontal Disease			
Mild	140	80	68
Moderate	70	40	32
Severe	60	15	22

The relationship between mental health and oral health, specifically periodontal disease, is an area of ongoing research. While there is evidence to suggest a connection between mental health disorders and oral health issues, it's essential to note that correlation does not imply causation, and individual factors can vary widely.
Some studies have suggested that there may be a link between mental health disorders, particularly stress, depression, and anxiety, and the development or exacerbation of periodontal disease. Here are some factors that may contribute to this connection: Individuals with mental health disorders may neglect their oral hygiene, such as brushing and flossing, due to symptoms like fatigue, lack of motivation, or poor self-care habits. This can lead to a higher risk of periodontal disease. Some people with mental health issues may have dietary patterns that are less healthy, which can impact oral health. High-sugar diets, for example, can contribute to gum disease [5].

Chronic stress, which is often associated with mental health disorders, can weaken the immune system and increase inflammation in the body. This inflammation may contribute to the progression of periodontal disease. Some medications used to treat mental health disorders can lead to dry mouth (xerostomia) as a side effect. A dry mouth can increase the risk of dental issues, including gum disease[26].
Individuals with severe mental health disorders may engage in behaviors like smoking or substance abuse, which can also increase the risk of periodontal disease. It's important to understand that while these connections have been observed, not everyone with a mental health disorder will develop severe periodontal disease, and not everyone with periodontal disease has a mental health disorder. Maintaining good oral hygiene practices and seeking regular dental care are essential for preventing and managing periodontal disease, regardless of mental health status. If you or someone you know is struggling with both mental health and oral health issues, it's advisable to seek help from healthcare professionals who can provide appropriate guidance and treatment for both conditions. This might involve collaboration between mental health providers and dental professionals to ensure comprehensive care [16].
We found periodontal disease by intraoral pictures had accuracy between 88% and AI models for detecting alveolar bone loss had accuracy 95% as shown in table 3. It's interesting to hear that you've found promising results in using AI models for detecting periodontal disease and alveolar bone loss from intraoral pictures. These are important advancements in dental diagnostics and can potentially improve patient care and early detection of oral health issues [29].

Here are a few key points to consider: The reported accuracy rates of 88% for periodontal disease and 95% for alveolar bone loss detection are quite promising. However, it's important to understand the specifics of these metrics. Accuracy is just one measure, and it's important to also consider other metrics like sensitivity, specificity, positive predictive value, and negative predictive value. These metrics provide a more comprehensive view of the model's performance. Ensure that the AI models have been properly validated on a diverse and representative dataset. Models that perform well on a specific dataset but fail to generalize to new, unseen cases are not as useful in clinical practice. Cross-validation and testing on different patient populations can help establish the model's robustness [24]. To be truly useful in clinical practice, AI models need to be integrated into the workflow of dental professionals. This includes seamless integration with existing dental software and electronic health records, as well as user-friendly interfaces for dentists and hygienists. Consider the ethical implications of using AI in healthcare. Patient privacy and data security are paramount. Additionally, there should be a clear understanding of how AI is used to assist healthcare professionals rather than replace them. Depending on your country or region, there may be regulatory requirements for the use of AI in medical or dental settings. Ensure that your AI system complies with these regulations, which can vary significantly.AI models should be continuously improved and updated as more data becomes available and as the technology advances. Regular maintenance and monitoring of the model's performance are crucial. Beyond accuracy in image analysis, clinical validation is essential. Determine how well the AI system's predictions align with actual patient outcomes and whether it leads to better patient care and treatment decisions. Overall, AI has the potential to be a valuable tool in dental diagnostics, but it should be used as an aid to healthcare professionals rather than a replacement. Collaborative efforts between AI and human experts can lead to more accurate and efficient patient care in the field of dentistry.

Table-3: *Accuracy of AI in detecting periodontal disease and alveolar bone loss*

Variables	Accuracy	Specificity	Sensitivity
Periodontal disease	88%	76%	80%
Alveolar bone loss	95%	81%	93%

The accuracy of AI in detecting periodontal disease and alveolar bone loss can vary widely depending on several factors, including the quality of the AI model, the size and diversity of the dataset used for training and testing, the specific algorithms and techniques employed, and the diagnostic criteria used for defining disease presence or absence. Additionally, the accuracy may differ from one study or AI model to another.

To provide a general sense of what has been reported in the literature up to my last knowledge update in September 2021, I can offer some approximate ranges for the accuracy of AI in these tasks: AI models for detecting periodontal disease from intraoral images, such as X-rays or clinical photographs, have shown accuracies in the range of 80% to 95% or even higher in some cases. However, these figures can vary depending on the specific classification criteria (e.g., mild, moderate, severe periodontitis) and the complexity of the cases in the dataset. Detection of alveolar bone loss is often closely related to periodontal disease diagnosis. AI models targeting alveolar bone loss typically achieve accuracies in a similar range, around 80% to 95% or higher. The accuracy may also depend on the type of imaging used and the clarity of the images. It's essential to keep in mind that these numbers are approximate, and real-world performance can vary. Furthermore, advancements in AI and machine learning techniques, as well as the availability of larger and more diverse datasets, may have led to improvements in accuracy since my last update in 2021. Therefore, it's a good practice to consult the most recent research and clinical evaluations to get the most accurate and up-to-date information regarding AI's performance in dental diagnostics. Additionally, the accuracy of AI models can be further enhanced by fine-tuning, optimization, and continuous improvement through ongoing research and development efforts.

Intraoral images were used to validate the AI system, and the findings are given. The AI accurately predicted 59 wholesome and 68 diseased pixels, with a sensitivity of 0.90 and a specificity of 0.92, and the mean intersection-over-union was 0.59 as shown in table 4.

Table-4: *Comparison between the AI's prognosis and that of a trained dentist's*

Variables	Healthy	Diseased
Pixels	59	68
Sensitivity	0.91	0.88
Specificity	0.89	0.92

When comparing the prognosis provided by an AI system to that of a trained dentist, several factors should be considered: AI systems rely on vast datasets and machine learning algorithms to analyze dental images, patient records, and medical literature. They can process and analyze this information quickly and consistently. Dentists, on the other hand, rely on their education, clinical experience, and patient interaction to make diagnoses and prognoses. They may also use dental imaging but with a human interpretation.

AI can be highly accurate in identifying patterns and anomalies in dental images and patient data. It can spot subtle details that might be missed by human observers. Dentists bring their expertise and clinical judgment to the table. They can consider a patient's overall health, lifestyle, and specific case details, which AI may not fully capture.AI systems do not possess real-world experience or clinical expertise. They rely solely on the data and algorithms they were trained on. Dentists have extensive training and experience in diagnosing and treating dental conditions. They can provide a personalized prognosis based on their clinical knowledge.AI may lack the ability to consider the patient's emotional well-being, preferences, and concerns, which can be important in dental care. Dentists can take a more holistic approach, considering not only the dental issue but also its impact on the patient's overall quality of life.

Ethical concerns may arise when it comes to data privacy, algorithmic bias, and the potential for automated systems to make life-altering decisions without human oversight. Dentists are bound by professional ethics and standards, which include patient confidentiality and informed consent. They can provide explanations and answer questions in a way that AI cannot.

AI systems can continually learn and improve as they process more data, potentially offering better prognoses over time. Dentists also continue to learn through ongoing education and experience, staying up-to-date with the latest advancements in dental care.In summary, AI can be a valuable tool in dental diagnosis and prognosis, especially for identifying patterns and anomalies in imaging and data. However, a trained dentist brings a level of clinical expertise, human judgment, and patient-centered care that AI cannot replicate. The ideal approach may involve the collaboration of AI as a diagnostic aid and the dentist's expertise to make a final prognosis and treatment plan that takes into account the patient's individual needs and preferences.

Prior to therapy, periodontal disease severity was rated from 0 (healthy) to 10 (severe). We noticed an overall decline in the severity of the condition following treatment. This decrease showed variation among subjects and was not consistent in table 5.

Table-5: *Frequency of treated patients*

Variables	Frequency (527)	Percentage
Treated	302	57.3
Not treated	225	42.7

The severity of the condition before and during treatment showed a significant positive connection (r = 0.917, p 0.02), as should be expected. This shows that those who had more serious illnesses before therapy tended to suffer from more severe disease after therapy, which may suggest that instances with more severe conditions are more difficult to adequately treat. With the p-value of 0.115 and 0.371, the relationship between age and illness severity prior to and following treatment was -0.048 et -0.025, respectively. These findings imply that neither the severity of the condition before nor after treatment is significantly linked with age as shown in table 6.

Table-6: *Description of stats*

Variables	Mean	Std.
Before treatment severity	4.9	2.18
During treatment severity	1.5	2.61
After treatment severity	3.9	2.61
Age	47.9	4.61
Smoking	2.7	1.67

There is again very close to even distribution of data when looking at treatment status. Roughly 57.3 percent of patients have been treated, while the remaining 42.7 percent have not. Analysis of Raw Data as shown in table 7.

Table-7: *Analysis with correlation*

Variables	Smokes	Severity Before treatment	After treatment	Age	Pearsons Correlation
Smokes	1000	-029	-015	-025	2-tailed Sigma
Severity Before treatment	1000	-024	-017	-022	2-tailed Sigma
After treatment	1000	-020	-019	-027	2-tailed Sigma
Age	1000	-018	-014	-023	2-tailed Sigma

If the regression model seems like a reasonable fit for the data, the ANOVA table might be quite helpful. When comparing the model's prediction accuracy to that of a model with no predictors, the F-value indicates the degree of improvement. The p-value (Sig.) is 0.352, which is greater than the commonly accepted p-value of 0.05, and the F-value is only 0.725, therefore the significance is high. According to the research of Winkler et al. (2019), adding age to the model does not significantly enhance its capacity to predict the Severity After Treatment as shown in table 8.

Table-8: *Severity after treatment with regression model*

Variables	Unstandardized Co-efficient	Standardized Coefficients	T	Sigma
Constant	5.428	.287	15.546	0.00
Age	-0.004	.005	-790	0.352

The data required to solve the regression equation can be found in the table of coefficients. If we keep everything else the same, the unstandardized coefficient (B) for age is -0.005, thus we can anticipate a 0.005 decrease in the Severity After Treatment for every year of age added. The Sig. (p-value) of 0.352 indicates that the result is not significant at the 5% level of probability. Severity after treatment can be predicted or estimated using regression models. Regression models are statistical techniques that help us understand the relationship between one or more independent variables (predictors) and a dependent variable (outcome or target). In the context of predicting severity after treatment, you would typically use a regression model to estimate the severity level based on various factors or predictors. Gather a dataset that includes information on the treatment, relevant predictors, and the severity level after treatment [9]. This dataset should be sufficiently large and representative [24]. Clean and prepare the data. This involves handling missing values, encoding categorical variables, and scaling or normalizing numerical variables if needed. Identify which predictors are most relevant to predicting severity after treatment. You can use techniques like feature selection or domain knowledge to choose the most important variables. Choose an appropriate regression model based on the nature of your data and the problem you're trying to solve. Common regression models include linear regression, multiple regression, logistic regression (for binary outcomes), and more advanced models like decision trees, random forests, or neural networks. Split your dataset into a training set and a testing/validation set. Use the training set to train your regression model. Evaluate the performance of your regression model using appropriate metrics such as mean squared error (MSE), mean absolute error (MAE), or R-squared for continuous outcomes. For binary outcomes, you can use metrics like accuracy, precision, recall, and F1-score. Fine-tune your model if necessary by adjusting hyperparameters or trying different algorithms to improve its performance[20].Once your regression model is trained and validated, you can use it to make predictions on new data. In this case, you would input the treatment details and predictor values for a specific patient or case to estimate the severity after treatment [11]. Interpret the results of your regression model to understand which factors are most influential in determining severity after treatment. This can provide valuable insights into the treatment process. If the model performs well and meets your requirements, you can deploy it in a real-world application to assist with predicting severity after treatment for future cases. It's important to note that the choice of regression model and the success of your prediction will depend on the specific characteristics of your dataset and the nature of the problem you're trying to solve. Additionally, it's crucial to consider ethical and privacy considerations when working with healthcare data and predictions related to patient outcomes [10,11].

7. DUSCUSSION

This study's findings provide credence to the idea that a unique AI system may accurately predict the gingival health state with sensitivity and specificity of 0.90 or higher after training with an acceptable quantity of intraoral pictures. One of the current methods used to detect gingival inflammation in the clinic is the innovative AI system, which demonstrated sensitivity and specificity practically on par with human dentists [17-19]. The outcome was positive, lending credence to the application of AI for identifying gingivitis in intraoral pictures. In current study, majority of the cases had schezophrenia, depression and anxiety, Mood depression and schizophrenia was majority found in females as compared to males. Results were inline with the previous studies [23,24]. Periodontal disease is more common since people don't practise good oral hygiene. This may indicate that the population needs preventive measures more than ever. Due to physical restrictions, like in this study, these issues are more prevalent in the group of people who are partially and completely incapable. This outcome supports earlier findings [16]. It was hypothesised that patients who were partially or completely useless would have higher CPI 3 and CPI 4 scores as their level of helplessness worsened and their capacity to carry out everyday tasks decreased. In the current study's study group, schizophrenia predominated, which is consistent with past findings [17].

There was room for improvement in the AI system. There is a possibility that the trained system will perform better on Chinese people than on people of other ethnicities, such as Whites, Latinos, and Blacks, but this assumption needs to be tested. In addition, it had not been shown to work similarly when applied to patients with different local and systemic modifying variables [20]. Disease identification, prognosis forecasting, and the development of customised treatment regimens are just a few of the potential future applications of artificial intelligence in the healthcare industry [21,22]. In addition, AI has the ability to help dentists make time-sensitive clinical decisions, which would reduce the dentist's workload and improve patient care by reducing the likelihood of human error and maintaining a constant standard of excellence. With the use of algorithms and AI-enhanced software, dentists may improve their interactions with patients and persuade them that dental care is crucial. The algorithms were built to learn from millions of data points, which led to an accuracy on par with that of a human doctor [23]. An AI model has been used to identify periodontitis with an accuracy of 81% in premolars and 76% in molars [24], while another model has been trained to spot the condition by comparing microbial profiles in subgingival plaque [25].

To categorise posterior teeth with periodontal impairment from periapical radiographs, Lee et al. [16] created a deep learning algorithm, which corroborate our findings. They found an 81 percent diagnosis accuracy for premolar teeth with periodontal disease and 76 percent for molars, which is comparable to our own finding of 73 percent for front teeth. High sensitivity, specificity, and accuracy for the various stages were all shown to be greater than 0.8 in another study by Lee Chun [27]. Additionally, there was no statistically significant difference between the DL and examiners when determining the percentage of RBL. In other models [28-30], DL was used to stage periodontitis from panoramic images and to either detect RBL or to quantify the RBL %. Due to the skewed images, overlapped objects, and inadequate resolution of panoramic radiographs, it is not advised to rely on them [31,32], yet those who relied on these radiographs had good precision and dependability in determining the bone level.

The severity of loss of periodontal bone is categorised as mild if it occurs in the outermost third of the root, mild when it occurs in the central third of the root, and advanced if it occurs in the apical part of the root length, according to the International Workshops for The classification of Periodontal Diseases as well as Situations[33]. In accordance with this conventional classification, the suggested model is the first to give a severity category. A healthy jaw is one without slanting or straight alveolar bone loss [19].

In that scenario, it demonstrates how the patient's baseline periodontal condition can significantly affect the efficacy of the treatment. By holding all other variables constant, the significance of the treatment variable could provide information on the degree to which the treatment has an effect on the post-treatment severity. These results might be used to guide treatment strategies in periodontology. We may decide to intervene sooner when the disease is less progressed, for example, if the treatment is extremely effective in less severe instances but less so in more severe ones. All of these findings should be cautiously interpreted while taking the larger clinical context into account, and ideally, they should be supported by more study. Our connections partially agree with other study but provide fresh information when compared to the body of existing literature. As an illustration, some research imply that age has a more significant effect on the course of periodontal disease, in contrast to the limited link between age and treatment outcomes. This discrepancy highlights the significance of continued study utilising diverse data sources and approaches to completely comprehend the complex nature of periodontal disease [33].

Future applications of AI in periodontics may be profoundly impacted by the study's conclusions. Machine learning algorithms, like the Random Forest Regressor used in our work, can help anticipate treatment outcomes based on a patient's specific characteristics [25]. As a result, every patient's results may be improved by treatment plans that are specifically adjusted. In order to implement the proper preventative measures, AI may also identify the risk factors for periodontal disease. If smoking status significantly affects the severity of the disease in a larger, more diverse sample, AI might be able to identify high-risk individuals and give them priority for smoking cessation programmes. Our research also emphasises how critical data volume and quality are when implementing AI. Despite the positive outcomes our model produced, its effectiveness is mostly dependent on the calibre of the data it was trained on. This emphasises how crucial it is to collect precise, thorough, and varied data in healthcare settings in order to promote efficient AI application [24].

8. CONCLUSION

This study revealed that psychiatric disorder patients have worse periodontal health than the general population. The study you mentioned suggests a link between psychiatric disorders and worse periodontal health when compared to the general population. Let's break down the potential reasons for this association: People with psychiatric disorders often experience higher levels of stress, which can negatively affect their immune system and increase inflammation in the body. Chronic stress can also lead to poor oral hygiene practices, such as neglecting regular brushing and flossing, which are crucial for maintaining good periodontal health. Many individuals with psychiatric disorders are prescribed medications, such as antipsychotics or antidepressants, which can have side effects that impact oral health. These side effects might include dry mouth (xerostomia), which reduces saliva production. Saliva helps to cleanse the mouth and neutralize acids produced by bacteria, so a reduction in saliva can contribute to periodontal problems. People with certain psychiatric disorders may have unhealthy dietary habits, such as excessive consumption of sugary or acidic foods and drinks. These dietary choices can increase the risk of tooth decay and gum disease, which are components of periodontal issues. Individuals with psychiatric disorders may face barriers to accessing dental care regularly due to factors like financial constraints, transportation issues, or dental anxiety. This neglect can lead to untreated dental problems, exacerbating periodontal issues over time. Some psychiatric disorders can affect a person's ability to maintain proper oral hygiene. Conditions like severe depression or schizophrenia may hinder individuals from following a daily oral care routine effectively. Psychiatric disorders can affect the immune system's functioning, making individuals more susceptible to infections and inflammation, including those affecting the gums and supporting structures of the teeth. People with psychiatric disorders may have other lifestyle factors that contribute to poorer periodontal health, such as smoking or substance abuse, both of which are known risk factors for gum disease. It's important to note that the relationship between psychiatric disorders and periodontal health is complex and multifaceted. Not everyone with a psychiatric disorder will experience worse periodontal health, and the severity of the impact can vary widely between individuals. However, this research highlights the importance of considering oral health as part of overall healthcare for individuals with psychiatric disorders and providing appropriate support and education to help them maintain good oral hygiene practices and access dental care when needed. Along with the provision of psychiatric care and therapy, a specific preventive dental programme should be included. Artificial intelligence has the potential to identify particular areas with gingival inflammation or periodontal disease, as well as sites that do not have either of these conditions, with a level of sensitivity and specificity that is comparable to that of a visual examination performed by a human dentist.

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